Toward a science and practice of resilience in the face of pain

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Statement of "significance":

What does this review add? The resilience approach put forward in this review spotlights sustainability of positive outcomes (e.g. engagement in meaningful activities) in the presence of pain as an outcome to pursue beyond recovery of negative outcomes. We illuminate the evidence-base and practical application of promising resilience mechanisms (positive emotions, psychological flexibility, needs satisfaction).

Abstract

Background and Objective: The primary objective of this paper is to discuss how a resilience approach to (chronic) pain may advance our current understanding of (mal)adaptation to pain. Different resilience perspectives are described, and future challenges for research, prevention and treatment of (chronic) pain are discussed.

Databases and Data Treatment: Literature searches were performed in Web of Science and PubMed to identify relevant literature on risk and resilience in the context of pain.

Results: Resilience can be best defined as the ability to restore and sustain living a fulfilling life in the presence of pain. The Psychological Flexibility Model, the Broaden-and-Build Theory, and Self-Determination Theory are described as theories that may provide insight into resilience within the context of (chronic) pain.

Conclusions: We describe how a resilience paradigm shifts the outcomes to pursue in pain research and intervention and argue the need for including positive outcomes in addition to negative outcomes. Psychological flexibility, positive affect and basic psychological needs satisfaction are described as potentially important resilience mechanisms with the potential to target both sustainability and recovery from pain. A resilience approach to chronic pain may have important implications for the prevention and treatment of chronic pain problems, as it may give specific indications on how to empower patients to continue living a fulfilling life (in the presence of pain).

1. Introduction

It is generally acknowledged that chronic pain has a great impact upon the daily lives of those suffering from this condition. In particular, pain may give rise to high levels of distress and even depression (Breivik et al., 2006; Miller and Cano, 2009). Furthermore, research has shown that a substantial number of adults and children/adolescents with chronic pain report high levels of disability (Goubert et al., 2004a; Häuser et al., 2014; Vervoort et al., 2014).

Importantly, a substantial number of individuals reporting high-intensity chronic pain seem to keep on functioning well in the presence of pain. Studies using the Graded Chronic Pain Scale of von Korff and colleagues (1992) have shown that 7.5% to 8.4% of adults reporting persistent (back) pain (Goubert et al., 2004a; Reid et al., 2011; Häuser et al., 2014) function well with high-intensity pain. As well, a recent study in 10650 schoolchildren showed that 19% of children reported pain of high intensity but low disability (Vervoort et al., 2014). This indicates that many individuals experiencing chronic or recurrent pain show *resilience*, which has been defined as "effective functioning despite the exposure to stressful circumstances and/or internal distress" (such as chronic pain) (Karoly and Ruehlman, 2006; Sturgeon and Zautra, 2010). Interestingly, a recent cohort study in Scotland using the Graded Chronic Pain Scale showed that 36.5% of individuals reporting high-intensity pain reported low pain-related disability and were identified as the "resilient" group while 63.5% of them reported high pain-related disability and were categorized as "non-resilient" (Elliott et al., 2014). This categorization proved able to predict long-term morbidity and mortality. Specifically, the authors showed that during the 10-year follow-up period, about one fifth (21.1%) of the group identified as resilient died while almost one third (31.9%) of the non-resilient group died. After adjustment for socio-demographic variables such as sex, age, housing, employment and long-term limiting illness, individuals categorized in the "resilient" group were 25% less likely to die within 10 years compared with individuals categorized as non-resilient (Elliott et al., 2014).

An important question that arises is how resilient individuals differ from non-resilient individuals. Studies have shown that resilient individuals report lower levels of risk factors, such as catastrophic thoughts about pain and pain-related fear. An early study of Karoly and Ruehlman (2006), in which individuals were categorized as resilient (i.e., demonstrating a response pattern consisting of high pain severity in the context of low interference and low emotional burden) or non-resilient (i.e., showing high pain severity and high disability), based upon the Profile of Chronic Pain:Screen (PCP:S) (Ruehlman et al., 2005), investigated differences in coping responses. This study showed that the resilient group reported relatively lower levels of pain-related fear, catastrophizing beliefs about pain, beliefs in a

medical cure for their pain problem, and self-reported disability than the non-resilient group.

This latter study indicates that resilient individuals evidence lower levels of risk factors than non-resilient individuals. A key question that follows is: Do resilient individuals only differ from non-resilient individuals on risk factors or also on positive attributes? One of the few existing studies that focus on this question, suggests that positive attributes such as engagement in positive self-talk, perceived control and social support indeed seem to differentiate resilient from non-resilient individuals (Karoly and Ruehlman, 2006). Related and largely unresolved key questions are: Which other positive attributes might differentiate both groups? And do positive characteristics and attributes have unique effects on functioning and health beyond the effects of risk factors in the context of chronic pain? Indeed, research has shown that positive attributes such as optimism and acceptance coping predict positive outcomes independently from negative personal characteristics and outcomes (Smith and Zautra, 2008). Moreover, in a study in women with musculoskeletal pain, it was also found that psychological distress and individual emotional and psychological well-being were only moderately related to each other, and both showed differential correlates (Huber et al., 2008).

This suggests that resilience is a distinct process from risk, and that factors relating to adaptive versus maladaptive functioning may not just represent two sides of the same coin (Sturgeon and Zautra, 2010; Wideman et al., 2013). Consideration of both risk and resilience mechanisms may therefore explain better than a sole focus on risk mechanisms why some individuals who experience high levels of pain may keep on functioning well in the presence of pain. A dual-factor model of risk and resilience in the context of chronic pain has been recently proposed in the context of adult pain (Sturgeon and Zautra, 2010; Yeung et al., 2012) and pediatric pain (Cousins et al., 2015). In these models, mechanisms that are related to resilience are distinguished from mechanisms related to risk and vulnerability.

In this topical review, we argue that both risk and resilience mechanisms should be considered in pain research and treatment. Furthermore, we describe how a resilience paradigm shifts the outcomes to pursue in pain research and intervention. In addition to negative outcomes such as disability and distress, also positive outcomes (e.g., engagement in values-based activities, psychological well-being, vitality, contribution to society) should be studied and targeted in clinical interventions. We will shortly delineate mechanisms related to increased risk for maladaptive outcomes (e.g., disability, distress) and mainly focus upon different perspectives on important resilience mechanisms which might contribute to positive outcomes and buffer against negative outcomes in the context of (chronic) pain. We will conclude with outlining challenges for future research.

2. Dual-Factor Model of Risk and Resilience

2.1. Optimal functioning within the context of pain: the need for positive outcomes in addition to negative outcomes

Understanding why some individuals continue to function well while experiencing persistent pain, may inform clinical practice with regard to the prevention and treatment of chronic pain problems. This resilience approach first necessitates a discussion of what we must consider 'functioning well' in the presence of persistent pain. In the resilience literature, two supplemental definitions of resilience exist that each involve different operationalizations of 'functioning well': recovery and sustainability (Sturgeon and Zautra, 2010; Zautra et al., 2010). Below we will discuss each of these definitions and related resilience outcomes. We will argue that recovery is already included in present pain research and is aligned with a focus on maladaptive, negative pain-related outcomes such as disability and distress. We will also argue, however, that sustainability is more innovative and highly useful for pain research, and requires a shift towards the inclusion of positive outcomes in pain research and intervention, *in addition* to presently used negative outcomes.

First, resilience is sometimes defined as *recovery*, i.e. the ability of a person to regain physical and psychological equilibrium and homeostasis following or during prolonged stress. This definition of resilience targets the stressor, in this case pain, and focuses on the negative deviations from prior functioning that arise from pain suffering and the extent to which one is able to minimize these deviations. Examples of recovery outcomes include the extent to which a patient undergoing a major surgery is able to minimize disability and the time it takes to regain his/her prior level of functioning, or the extent to which a chronic pain sufferer is able to minimize depressive symptoms and/or disability over the course of the pain trajectory. Thus, recovery seems to be involved already in the present pain literature and is directly related to maladaptive pain-related outcomes such as pain disability and mood disturbance. However, we are still quite ignorant about resilience mechanisms that prevent or minimize, or speed recovery from, these outcomes in addition to known risk mechanisms.

Second, *sustainability* is the ability of a person to move towards long-term positive outcomes in life in the presence of adversity. Sustainability, in contrast to recovery, is mostly aligned with positive outcomes and has not gained much explicit attention in pain research. The few existent studies on resilience in chronic pain defined resilient individuals in terms of the absence of disability, burden and psychopathology, and thus, recovery (Karoly and Ruehlman, 2006; Elliott et al., 2014). In contrast to the stressor, or pain itself, the concept of sustainability targets *the person* challenged by pain. The experience of (chronic) pain is one

of many adverse contexts that persons may encounter during life, that need to be managed in the pursuit of long-term positive outcomes. A focus on long-term positive outcomes is aligned closely to the framework of positive psychology, of which the founding father is Martin Seligman (Seligman and Csikszentmihalyi, 2000; Seligman et al., 2005). Positive psychology focuses on human thriving and emotional, psychological and social flourishing in life, and its contributing factors. It can be considered an addition to existing psychological mainstream science that focuses primarily on pathology. The main assumption of positive psychology is that positive, healthy aspects of life are *not* simply the opposite of distress and dysfunctioning. Both need to be integrated and equally weighted to optimally understand and cure disorder (Wood and Tarrier, 2010). In line with the framework of positive psychology, sustainability might then be operationalized as the continuing experience of *optimal emotional, psychological and social well-being* in the presence of pain. This involves, among other things, the capacity to experience high life satisfaction, be self-determining and independent, experience and build positive social ties and interactions, accept the self in all its aspects, and understand and contribute fruitfully to society. The ability to simultaneously experience high levels of emotional, psychological and social well-being has been coined 'flourishing' (Keyes, 2002; 2005). Perhaps the most important sustainability outcome in the context of chronic pain that is part of the pursuit of optimal wellbeing or flourishing, is the extent to which one is able to engage with meaningful, values-based activities and goals in the presence of pain (McCracken and Yang, 2006; Sturgeon and Zautra, 2010).

Although recovery and sustainability outcomes are probably interrelated to some extent (i.e. sustainability is potentially better achieved when recovery is optimal versus non-optimal or absent), they might also function independently from one another. As mentioned above, positive psychology assumes that positive, healthy aspects of life are *not* simply the opposite of distress and dysfunctioning. Indeed, numerous studies offer empirical evidence for the fact that psychopathology and optimal well-being are only moderately related and function relatively independent from one another (Huppert and Whittington, 2003; Westerhof and Keyes, 2009; Lamers et al., 2011; 2015; Weich et al., 2011). Similarly, recovery and sustainability of functioning might function along two related, but different axes. This is especially relevant in the case of *chronic* pain as an ongoing, often unresolvable stressor, where it might be most helpful for a pain sufferer to focus on *both* recovery and sustainability, or even shift total focus towards sustainability as the *only* desired outcome of functioning. Even when this shift in focus is embraced at present, for example in the psychological flexibility model (McCracken and Morley, 2014), the primary outcomes often measured in present pain research are more aligned with recovery than sustainability. For example, studies testing the effects of Acceptance & Commitment Therapy (ACT) based on the psychological flexibility model that is directly in line with a focus on sustainability, often apply

a myriad of recovery outcomes such as pain disability and depressive symptoms while not measuring sustainability outcomes such as life satisfaction or values-based action (e.g., Kemani et al., 2015). A resilience framework clarifies how both maladaptive pain-related (negative) outcomes and adaptive (positive) outcomes focusing on the person suffering from pain are important for our understanding of functioning well with persistent pain, and also directs our attention towards "resilient individuals" and both the risk and resilience mechanisms that underlie their adaptive functioning.

2.2. Risk mechanisms

In the past few decades, several neurobiological and psychosocial risk mechanisms for developing chronic pain and/or pain-related disability have been identified. Recent research has for instance proposed reduced reward responsiveness as a neurobiological marker of chronic pain vulnerability (Denk et al., 2014; Elvemo et al., 2015). With regard to psychosocial risk mechanisms, the Fear-Avoidance Model has proliferated our knowledge on the development and treatment of pain-related disability and distress in adult and pediatric populations (Vlaeyen and Linton, 2000; Leeuw et al., 2007; Asmundson et al., 2012; Goubert and Simons, 2013). Accumulating research demonstrates that when individuals, adults as well as children/adolescents, respond with catastrophizing thoughts and pain-related fears in response to pain, they may try to avoid all kinds of activities that are expected to induce or heighten pain. Prolonged avoidance may, however, lead to long-term disability and even depression, and may intensify the internal experience of pain (Vlaeyen and Linton, 2000; 2012; Sullivan et al., 2001; Goubert et al., 2004b; Leeuw et al., 2007; Asmundson et al., 2012; Crombez et al., 2012; Goubert and Simons, 2013; Wideman et al., 2013).

Moreover, also social-contextual factors have been found to increase the risk for adverse outcomes, by influencing these fear-avoidance processes in individuals (Hadjistavropoulos et al., 2011; Goubert and Simons, 2013). Evidence is for instance accumulating showing that catastrophizing and protective/solicitous behaviours of parents or partners may contribute to heightened disability (Newton-John, 2002; Cano et al., 2005; Goubert and Simons, 2013). Furthermore, preliminary evidence is available that parental catastrophizing cognitions and protective behaviours may be important in the intergenerational transmission of chronic pain. A recent study in parents with and without chronic pain for instance showed that parents with chronic pain were more likely to catastrophize about their child's pain and respond with protective behaviours than parents without chronic pain (Wilson and Fales, 2015). Observational learning of pain-related fear, catastrophizing thoughts and avoidance behaviours, has been suggested as a potential mechanism of intergenerational transmission of chronic pain problems (Goubert et al., 2011;

Helsen et al., 2011; 2013; 2015). An increased understanding of those intrapersonal and interpersonal risk mechanisms over the years has informed and improved the multidisciplinary treatment of chronic pain, in which risk mechanisms such as pain-related fear and catastrophizing thoughts about pain are primary targets of the intervention (Williams et al., 2012; Ehde et al., 2014). A critical note that can be raised here is that this research mainly focused on risk mechanisms for negative outcomes such as disability, but often neglected the measurement of positive outcomes (e.g., are higher levels of catastrophizing predictive of less positive outcomes) and the consideration of positive characteristics (i.e. resilience mechanisms) in explaining and predicting patient outcomes (but see Trompetter et al., 2016).

2.3. Resilience resources and mechanisms

Knowledge on risk mechanisms may not be sufficient to explain why a substantial amount of individuals seem to keep on functioning well or even 'flourish' within the context of pain. Much less investigated, however, are variables that may explain and predict continued and adaptive functioning in the presence of pain. In the dual factor model of risk and resilience (Yeung et al., 2012), a differentiation is made between resilience resources and resilience mechanisms. Resilience *resources* are more stable-like characteristics, while *mechanisms* are modifiable mechanisms that represent the link between the resources and outcomes. Both resources and mechanisms may reside at physiological, emotional, psychological and social or societal levels. A promising physiological resource of resilience to pain, that is mostly related to individual recovery, is respiratory sinus arrhythmia, a measure of heart rate variability and the primary index of the ability of the nervous system to appropriately organize an affective homeostatic response to situational demands. As such, it may buffer the influence of the sympathetic nervous system on physical functioning (Sturgeon et al., 2014). Relatedly, in an experimental study, greater low frequency heart rate variability was associated with lower ratings of pain unpleasantness and higher pain thresholds (Appelhans and Luecken, 2008).

A personality characteristic that may represent a psychological resource of resilience is optimism. Research has shown that optimism is linked to lower levels of pain. For example, an experimental study in 114 healthy volunteers showed that higher levels of dispositional optimism were associated with lower levels of pain report when participants were asked to immerse their hand in a box filled with cold water (Hood et al., 2012). Lower levels of catastrophizing thoughts about pain explained this relationship. In another experimental study in 140 individuals with knee osteoarthritis, it was found that dispositional optimism was linked to less temporal summation of pain. Again, this relationship was

mediated by catastrophizing about pain (Goodin et al., 2013). Peters and colleagues (2010) investigated the predictive role of optimism in explaining recovery after surgery. They found that optimism predicted better (long-term) outcomes such as mental health and vitality 12 months after surgery.

An example of a well-studied social resilience resource is the experience of social support. In an experimental setting with 101 healthy volunteers, both active and passive social support given by either a friend or stranger was associated with lower reported levels of pain following a cold pressor task (Brown, 2003). Cross-sectional studies indicated that social support plays a buffering role in the experience of pain, disability and impaired mental health (Kerns et al., 2002; Raichle et al., 2007). Further, Evers and colleagues investigated the predictive role of perceived social support at the time of diagnosis of rheumatoid arthritis. In their study, higher levels of social support predicted lower levels of functional disability and pain at three- and five-year follow-ups (Evers et al., 2003). Recent research in the context of couples experiencing chronic pain furthermore suggests that social support might be most helpful when the support is provided for volitional motives (e.g., providing help out of enjoyment) than for controlled or pressured motives (e.g., providing help to avoid guilt or criticism) (Kindt et al., 2015; 2016).

Other examples of potentially interesting resilience resources and mechanisms that gained varying research attention include secure attachments, benefit finding, trait resilience, hope and social intelligence (Ciechanowski et al., 2003; Gatchel et al., 2007; Smith et al., 2009; Tremblay and Sullivan, 2010; Ramírez-Maestre et al., 2012; Sturgeon and Zautra, 2016). Pain self-efficacy has received quite some research attention as a resilience mechanism explaining less impairment, affective distress and pain severity (Jackson et al., 2014; Tomlinson et al., 2017).

Most of the research described in this paragraph only focuses on the role of resilience resources and mechanisms for *recovery* from chronic pain, and failed to consider *sustainability* as an important resilience outcome. In the next paragraphs, different perspectives on modifiable resilience mechanisms, arising from research traditions that explicitly relate to the earlier described definitions of sustainability are discussed in the context of (chronic) pain.

3. The psychological flexibility model

A first research tradition that studies the mechanisms by which individuals can live a fulfilling life in the presence of pain that has received quite some research attention focuses upon the concept of psychological flexibility (McCracken and Marin, 2014; McCracken and Morley, 2014; McCracken and Vowles, 2014). This approach is grounded within a philosophy

of science named functional contextualism (Hayes et al., 2012a). A key assumption of the psychological flexibility model is that negative experiences such as fear, distress and pain are common and considered not pathological in nature all by themselves. They may, however, hinder our ability to persist or change behaviour in line with our long-term goals and values based on an open-minded awareness of the present context. This is especially so when individuals are insensitive to their direct experiences (what we see, smell or hear) and led by verbal or cognitive processes such as the stories we have about ourselves, or rules we build to act on the world independent of context. To overcome the governing role of such verbal and cognitive processes, metaphors are often used to explain the core principles of psychological flexibility. One such metaphor is that the the best road toward resilient outcomes, including recovery, sustainability and (potentially) growth, is the one in which an individual takes his/her inner experiences (including negative ones) with him/her while at the same time engaging in goal-directed actions in line with personal values (e.g., invest in hobbies, doing fun things with children) (McCracken and Marin, 2014; McCracken and Morley, 2014; McCracken and Vowles, 2014).

Six core processes have been identified as being characteristic of psychological flexibility, which are represented in the so-called "hexaflex", i.e. acceptance, defusion, self-as-context, contact with the present moment, values, and committed action (see McCracken and Morley, 2014). Together, acceptance and defusion represent the 'open response style', characterized by the ability to disengage from, and take an open and accepting stance towards, pain, distress, and negative emotions and cognitions such as fear and catastrophizing. An open response style enables one to adopt another response style in which one actively engages in life and freely chooses activities that are meaningful to oneself, even in the presence of pain. This second response style is referred to as the 'engaged response style' and includes the processes of values and committed action. Finally, the processes self-as-context and contact with the present moment are included in the 'centered response style'. This response style is highly associated with mindfulness. It helps to relate to pain and related negative experiences from moment-to-moment and from an observing, non-judgemental stance. This stance can be seen as a necessary or at least helpful basis from which to pursue the other two response styles from. Together, these six processes constitute psychological flexibility, the ability to engage in meaningful activities in the presence of pain, distress and unwanted pain-related emotions and cognitions (McCracken and Morley, 2014). All six processes, and psychological flexibility in general, can be considered as positive, modifiable resilience mechanisms that may improve the ability to ward off, buffer against, and recover from disability. Simultaneously, they seem to enable patients to sustain or increase the engagement in fulfilling and meaningful activities.

Research has shown that higher levels of psychological flexibility, and its

subprocesses (primarily acceptance, mindfulness, committed action) are related to lower symptom severity, physical and psychological disability, interference in work and other daily activities, negative affect, depression and pain-related anxiety, and to more positive affect, better performance of activities, and more emotional stability in chronic pain and chronic fatigue samples (Viane et al., 2003; McCracken and Eccleston, 2005; McCracken and Yang, 2006; Van Damme et al., 2006; McCracken et al., 2007; Vowles and McCracken, 2008; McCracken and Gutierrez-Martínez, 2011; Cho et al., 2013; Trompetter et al., 2015a). An experimental study by Petter and colleagues (2014) showed that an induction of state mindfulness was indirectly related to lower levels of pain and better pain tolerance, mediated by changes in pain catastrophizing. Furthermore, a brief mindfulness intervention showed beneficial effects upon experimental pain perception, i.e. increased heat pain threshold and more rapid attenuation of pain intensity for tonic pain stimuli (Reiner et al., 2016). Interestingly, higher levels of (self-reported) mindfulness have also been related to less frequent use of opioids to self-medicate negative emotions (Garland et al., 2015). The evidence base for the role of psychological flexibility and its subprocesses in adaptation to chronic pain is growing rapidly.

Acceptance and Commitment Therapy (ACT) is a behavioural therapy of the third generation based upon the psychological flexibility model that centrally aims at restoring and/or promoting values-based functioning (Hayes et al., 2012b; McCracken and Marin, 2014; McCracken and Morley, 2014). A recent systematic review including 10 randomized controlled trials (N=623) in adults with chronic pain, investigating 15 outcome domains, showed that ACT seems to be efficacious, particularly with regard to outcomes of physical and emotional functioning, including anxiety and depression (Hann and McCracken, 2014). These outcomes were similar to a recent meta-analytic review of acceptance- and mindfulness based interventions, including 12 randomized controlled trials on ACT, for chronic pain (Veehof et al., 2016). Overall, effect sizes in this meta-analysis were mostly moderate, which is similar to the average effects of Cognitive Behavioural Therapy. Despite the usefulness of the psychological flexibility model and these promising effect sizes, some caveats in research on ACT have been identified that may direct future research endeavors. Primarily, studies using ACT often have small sample sizes and there are significant risks of bias, necessitating more high-quality studies. Also, most randomized controlled trials on ACT only included inactive control conditions such a waiting-list control condition instead of active control conditions. However, existing trials on ACT with better designs show similar effects as the meta-analyses described (e.g., Trompetter et al., 2015b). To further improve our understanding of how ACT can impact recovery and sustainability, future longitudinal intervention research examining the (combined) role of each of the six different subprocesses of psychological flexibility might be informative (see Vowles et al., 2014a;

2014b; Scott et al., 2016).

4. Broaden-and-Build Theory: the role of positive affect

The second approach to resilience that is relevant in the context of (chronic) pain focuses upon positive affect and is grounded in the positive psychology tradition. One of the most influential theories in this regard is the Broaden & Build Theory of Positive Emotions, developed by Barbara Fredrickson and colleagues (Fredrickson, 2001, 2013; Fredrickson and Losada, 2005). According to this theory, positive affect *broadens* people's visual awareness, attention, thoughts and behaviour (Waugh and Fredrickson, 2006; Rowe et al., 2007), enabling a larger range of behavioural options. As an example, participants induced with positive emotions listed more specific activities they would like to do right now than participants induced with neutral or negative emotions (Fredrickson and Branigan, 2005). In the long term, this moment-to-moment broadening builds enduring personal resources over time, such as social support (Fredrickson et al., 2008), and enhances physical health, life fulfilment and even survival (Fredrickson and Levenson, 1998; Kok et al., 2013). Additionally, earlier studies demonstrated the un-doing effect of positive emotions (Fredrickson and Levenson, 1998; Fredrickson et al., 2000). Specifically, the induction of positive emotions has been shown to facilitate a faster recovery from physiological stress induced by negative emotions.

Hence, similar to psychological flexibility, positive affect seems to be a resilience mechanism that buffers against stress and negative emotions. Simultaneously, it functions as a resource for positive short- and long-term outcomes in multiple life domains. The buffering effect of positive emotions is also central to another model that investigates the role of positive affect, the Dynamic Model of Affect developed by Zautra and colleagues (Zautra et al., 2001; Reich et al., 2003; Davis et al., 2004). The main assumption of this model is that positive affect has the strongest beneficial effects under conditions of high stress relative to low stressful situations. In low stress conditions, the occurrence of positive and negative affect seems to be relatively independent. In high stress situations, such as in the context of high levels of pain, there seems to be an inverse relationship between positive and negative affect, which leads to the hypothesis that augmenting positive affect should decrease negative affect in the context of high intensity pain.

What is the current evidence on the role of positive affect, independent from negative affect, in the context of pain? First of all, in numerous experiments positive emotions primarily seemed to lower pain sensitivity following acute pain inductions (Finan and Garland, 2015). In a recent experiment, positive emotions impaired the generalization of fear of movement from acute experimental pain to similar situations during an experiment with

healthy individuals (Geschwind et al., 2015). In the context of chronic pain (for reviews, see Finan and Garland, 2015; Ong et al., 2015), among other things, positive emotions appear to foster lower pain levels and adaptive recovery from pain (Zautra et al., 2001; 2005b). Moreover, the ability to sustain positive emotional states during times of high pain buffers against negative affective states and future pain episodes (Davis et al., 2004). Research also suggests that fibromyalgia patients, compared to other patient groups, may be at higher risk for a deficit in positive affect and an inability to sustain positive affect in the face of pain (Zautra et al., 2005a; van Middendorp et al., 2008; Finan et al., 2009). Genetic research is trying to disentangle the underlying processes. It has been suggested that this possible deficit in positive affect may be undergirded by a chronic impairment in dopaminergic activity (Finan et al., 2010).

First efforts have been performed to make positive emotions a more central focus of interventions for people suffering from chronic pain (Davis and Zautra, 2013). Specifically, positive emotions may be enhanced to act as a direct buffer for negative qualities such as catastrophizing, negative feelings and stress (Fredrickson and Levenson, 1998; Zautra et al., 2001; Ong et al., 2010). Furthermore, according to the Broaden-and-Build Model (Fredrickson 2001), promoting positive emotions may broaden attention toward positive aspects of one's life that are still present. Hence, positive emotions potentially interfere with, or buffer against the downward spiral of disability, while they simultaneously support an upward spiral of goal-directed action based on personal values (see also Finan and Garland 2015). Hereby, positive emotions support both resilience outcomes of sustainability of the positive in life and recovery (Sturgeon and Zautra, 2010). Positive psychology strategies such as the 'three good things exercise' (Duckworth et al., 2005; Seligman et al., 2005) may for instance be used during intervention to direct attention of patients toward positive experiences they may have in daily life. Other strategies, such as loving-kindness meditation (Fredrickson et al. 2008) or savoring of past, present or future positive events, may also help to enhance positive emotions, and in this way broaden awareness of patients toward positive aspects of their lives, things that go well in life, and may help in getting out of the spiral of negative feelings and thoughts. Furthermore, experiencing mild positive affect may help in stimulating patients getting active again. Indeed, getting active again after prolonged periods of reduced functioning and deconditioning of the body (Verbunt et al., 2003) may be extremely hard for patients. Finding activities they enjoy and experiencing mild positive emotions during activity may be key for getting patients active again, and letting them stay active on a long-term basis (see also Fredrickson, 2013).

The evidence base for the effects of positive psychology interventions is growing. The results of two meta-analyses indicated that positive psychology interventions significantly increase well-being and decrease depressive symptoms, with small to medium effect sizes

found (Sin and Lyubomirsky, 2009; Bolier et al., 2013). However, Bolier et al. (2013) concluded that the quality of the studies varied considerably, and that indications for publication bias were found. More high-quality studies are needed to strengthen the evidence-base for positive psychology interventions. Research addressing the question whether positive psychology interventions may benefit individuals with chronic pain or prevent acute pain from developing into chronic pain is still in its infancy (Hausmann et al., 2014; Flink et al., 2015). It has been suggested that positive psychology interventions might be a promising alternative for existing interventions, as they are non-stigmatizing, do not require a mental health professional for its provision, and can be provided via online means (Hassett and Finan, 2016). However, few studies are available yet, with mostly small sample sizes that lack an active control group. Recently, Müller et al., (2016) showed that a computer-based positive psychology intervention might be feasible, acceptable and efficacious for improving wellbeing and pain-related outcomes (e.g., pain intensity, pain interference, pain control) in individuals with chronic pain and physical disabilities. A larger evidence-base may further our understanding of the role of positive emotions, and interventions based on positive psychology, in adaptation to chronic pain. Especially necessary is research aimed at better understanding if and how positive affect might support sustainability of psychological and social wellbeing, and specifically the pursuit of meaningful activities in life in the context of chronic pain. Future research should also disentangle for which individuals positive psychology interventions might be most beneficial.

5. Self-Determination Theory: the role of psychological need satisfaction

A third approach to resilience which may be relevant to the context of pain is Self-Determination Theory (SDT; Ryan and Deci, 2000), which originates from an organismic-dialectical perspective upon human functioning. The main assumption of SDT is that humans are active, growth-oriented organisms. Just as a plant needs soil, water, and light to thrive, individuals have a set of innate psychological needs, the satisfaction of which are critical for individuals to grow and reach their full potential (Ryan and Deci, 2000). Specifically, well-being and growth are facilitated by the satisfaction of individuals' need for autonomy (through volitional engagement in interesting and values-based activities), competence (feeling capable, self-efficacious and optimally challenged through the gradual development and refinement of one's capacities) and relatedness (having a sense of belonging and feeling connected to others through the pursuit of satisfying relationships). When individuals are confronted with (chronic) pain, their innate needs may become frustrated, which may result in reduced well-being, reduced motivation to engage in activities, and disability. For instance,

autonomy needs may be frustrated because pain is an obstacle to engage in personally meaningful activities like playing sports, competence frustration may occur because they feel incapable of doing particular activities as well as they used to and/or because they feel frustrated because they are not able to cope well with pain, and frustration of relatedness needs may occur because they feel hampered in doing activities with for example their partner or children because of the pain.

SDT posits that the degree to which these innate needs are satisfied or hampered determine motivation to engage in (daily) activities. When needs are satisfied, individuals typically engage in activities for autonomous or volitional reasons (e.g., because they like to do these activities or because they find them important). On the other hand, need frustration typically gives rise to so-called controlled motivation, in which individuals feel forced to engage in activities (by others or via self-enforced guilt). Extensive research evidence shows that pursuing activities for volitional reasons instead of controlled reasons leads to enhanced performance, persistence, heightened vitality, more self-esteem and higher general well-being (Ryan and Deci, 2000; Vansteenkiste and Ryan, 2013). In the context of pain, the challenge is to keep engaging in activities for autonomous instead of controlled reasons, key of which may be the continued satisfaction of these basic needs. In contrast, need thwarting may give rise to compensatory behaviours such as diminished self-control (manifested through for instance alcohol or medication abuse) and rigid behavioural patterns (Vansteenkiste and Ryan, 2013). In the latter case, individuals may compulsively stick to certain behavioural patterns because they provide a sense of predictability and security (Vansteenkiste and Ryan, 2013). In the context of pain, individuals may for instance persistently try to avoid activities which they think will augment their pain, depriving them from activities which may potentially satisfy their basic psychological needs. Although this approach to resilience seems very promising to understanding behaviour, well-being and functioning in the context of pain, research is scarce.

Autonomy support has been identified as crucial in promoting the satisfaction of individuals' basic psychological needs (Ryan and Deci, 2000). In the context of health care, autonomy support involves acknowledging a patient's perspective, giving choices for treatment options, and providing a rationale for treatment recommendations (Uysal et al., 2016). Although research in the context of pain is scarce, a recent study suggests that health care professionals can be trained in the use of need-supportive communication (Murray et al., 2015), although (long-term) effects upon patient outcomes should still be examined. Of relevance is a longitudinal study in patients with chest pain which showed that physicians' autonomy-supportive style predicted more patient autonomous motivation for lifestyle change (Williams et al., 2005). In the context of intimate relationships, a recent study in married individuals with musculoskeletal pain demonstrated that autonomy support by the spouse

predicted increases in patients' need satisfaction, which on its turn predicted increases in well-being (Uysal et al., 2016). Another study found that perceived autonomy support for being active by the spouse stimulated daily engagement in physical activity in patients with knee osteoarthritis, while male patients were found to spend less time in physical activity on days in which they perceived pressure from their spouse to be active (Martire et al., 2013). SDT may also provide an explanation for the often observed negative effects of partners' solicitous behaviours upon patient well-being and functioning, as solicitous behaviours may be perceived by patients as controlling or thwarting competence needs by patients (Newton-John, 2002).

Given the considerable evidence base for SDT in other (health-related) contexts (Ng et al., 2012), SDT may be of relevance to better understand how patients with chronic pain may be helped in their road towards recovery and/or sustained engagement in important and meaningful activities. Questions for future research may include how some individuals are capable of nurturing their basic psychological needs in the face of pain and continue to function well, and how those needs may be fed in those that experience huge challenges in keeping their basic needs satisfied and stay motivated to engage in activities which make them feel competent and in which they experience meaningful connections with important others. Furthermore, future research should examine how autonomy support by partners and health care providers may promote basic needs satisfaction, and in this way positive outcomes in patients with recurrent or chronic pain, and how important others can be learnt to provide autonomy support.

6. Conclusions

A central psychological explanatory model of chronic pain disability that underlies clinical practice is the Fear-Avoidance Model (Leeuw et al., 2007; Crombez et al., 2012). This model describes risk mechanisms for disability at emotional (e.g., fear), cognitive (e.g., catastrophizing) and behavioural (e.g., avoidance) levels. Risk mechanisms are pictured in the 'downward spiral' of pain disability on the left side of Figure 1. These risk mechanisms have one central quality: It causes the pain to be the central and continuous focal point of all attention, thoughts and behaviour. Detrimental side effects of these risk mechanisms are the continuous impairment of the moment-to-moment potential of broadening an individual's attention to other aspects of life, and the simple fact that it reduces the energy and time available to work towards the engagement in valued life activities. Thus, despite the usefulness of narrowing one's attention to pain (control) in response to acute or solvable adversity, the continuous direction of energy to the control or removal of pain seems counterproductive when suffering from ongoing, largely insolvable, chronic pain. This is

especially so as the goals related to sustaining a good life may stand in sharp contrast to goals related to pain control and avoidance (Van Damme et al., 2010). To summarize, the primary challenge of individuals with chronic pain is to reorient attention from pain into the engagement in activities serving personal values in order to enhance the sustainability of well-being in daily life, and let go of the persistent struggle to remove or control pain (especially when this struggle interferes with personal goals).

From a resilience perspective, health must always be considered from a dual perspective that includes both recovery (i.e. from disability, depressive symptoms etc.) as well as sustainability of the good in life (i.e. by engaging in values-based, meaningful activities). Depending on the stressor one is faced with, more or less emphasis can or needs to be placed on either recovery or sustainability. In the case of an acute pain experience (e.g., surgery), recovery to the previous level of functioning is likely the most important focus of intervention. In contrast, when considering the challenge of chronic pain from a resilience perspective, the strongest focus of intervention should be on behaviour change and sustaining, restoring, or promoting the undertaking of personal goal-directed actions in the presence of pain. Importantly, dual-factor models of risk versus resilience mechanisms, and psychopathology versus well-being, suggest that an upward spiral of resilient and sustainable functioning includes mechanisms that are different from the negative mechanisms of a downward spiral of disability. Interfering with the downward spiral of pain disability is therefore not enough to improve sustainability. In order to promote this upward spiral, it may therefore be highly useful to increase resilience mechanisms. *Optimally, we search for resilience mechanisms that contribute to an upward spiral of sustainability, that simultaneously provide a buffer against, or moderate, risk mechanisms and disability (see Figure 1).* Psychological flexibility, positive emotions and satisfaction of basic psychological needs seem to possess these qualities.

- Insert Figure 1 about here –

7. Future challenges

Many challenges remain with regard to theory and practice of resilience within the context of pain. First, most studies to date have been executed in patients presenting in specialty clinics, showing a lot of disability. However, we might learn a lot on mechanisms that protect against the development of chronic pain problems and disability from individuals who succeed in sustaining optimal well-being in the presence of (high-intensity) pain. Promoting crucial resilience mechanisms (e.g., psychological flexibility, positive affect, needs

satisfaction) may then prove useful as an intervention strategy in the context of public health interventions aimed at the prevention of chronic disability in healthy individuals and patients presenting with acute pain (see also Fledderus et al., 2010). At present, research on the promotion of resilience mechanisms as a prevention strategy is almost non-existent in the context of pain.

Second, more research is needed regarding (the specific ingredients of) interventions that may promote resilience mechanisms and at the same time reduce risk mechanisms in patients with chronic pain. Future research should also address the question for whom different types of treatment (that target the reduction of risk mechanisms or enhance resilience mechanisms or both) may be most beneficial (see Day et al., 2015).

Third, we propose that resilient outcomes are defined in future studies as a combination of recovery (e.g., from disability) ánd the presence of a fulfilling life (sustainability). To date, however, studies have mostly defined "resilience" or "functioning well" as the presence of pain combined with an absence of physical and/or emotional disability. Based on conceptualizations of resilience (Zautra et al. 2010) and multiple lines of research that suggest that positive and negative resources, mechanisms and outcomes are two-dimensional, we have argued in this paper that resilience is more than the sole absence of disability. Practically, this means that measurement instruments that operationalize the dimensionality of resilient functioning (assessing both recovery ànd sustainability) must be implemented in future research. Several existing measures developed outside the pain research area might be useful to assess sustainability. First of all, the Mental Health Continuum (MHC-short form) is an overarching measure of optimal emotional, psychological and social well-being developed within the framework of positive psychology. The scale has good psychometric and conceptual properties (Keyes, 2002; Lamers et al., 2011). The Engaged Living Scale (ELS) (Trompetter et al., 2013) can be used to measure insight in personal values and the subsequent pursuit of engaged activities. Furthermore, given its positive focus ánd the combination of psychological and physiological components of well-being, the Subjective Vitality Scale (SVS) may be of interest for future study (Ryan and Frederick, 1997). If researchers want to measure sustainability but also adhere to IMMPACT guidelines on recommended core outcomes of clinical trials with chronic pain (Dworkin et al., 2005), we suggest using the subscale Pain Interference of the Multidimensional Pain Inventory as the primary outcome of study (Kerns et al., 1985). Furthermore, future research should discern how the seemingly related but simultaneously different resilience outcomes of recovery and sustainability relate to each other, and examine if these outcomes have different or similar resilience resources and mechanisms.

Fourth, methodological challenges remain with regard to the assessment of resilience resources and mechanisms and its underlying processes. For instance, although

psychological flexibility is by definition a very dynamic construct involving relationships between different variables, most studies have only used questionnaires, administered at one time point, to measure this construct and relate it to outcome measures. It is a huge challenge for future research how we should operationalize and measure the dynamic qualities of resilience mechanisms such as psychological flexibility, and its relationships with risk mechanisms and outcomes. We might need alternative research designs (e.g., diary methods, experimental research methods) and data analysis methods (e.g., person-centred in combination to variable-centered analyses) to get a view on the dynamic interplay of risk and resilience mechanisms that play a role in the prevention and treatment of chronic pain problems. Furthermore, it is yet largely unknown how different (stable) resilience resources (e.g., optimism) impact outcomes. Most studies examining the impact of resilience resources only refer to a reduction of risk factors as an explaining mechanism (see e.g. Hood et al., 2012; Goodin et al., 2013), but more insight into how resilience resources, mechanisms and risk mechanisms each contribute to recovery ànd sustainability and how risk and resilience mechanisms may work together in impacting these pain-related outcomes is necessary. A first study by Alschuler et al. (2016) in patients who participated in a self-management intervention for chronic pain showed that risk and resilience mechanisms together accounted for a substantial amount of variance in physical outcomes. Interestingly, resilience mechanisms uniquely impacted mental health outcomes beyond risk mechanisms. Future research using a person-centered analytic approach may try to identify risk and resilience trajectories individuals follow when confronted with an acute episode of pain (Laursen and Hoff, 2006).

Finally, an important direction for future research is the examination of interpersonal dynamics of resilience. Accumulating evidence shows that the social environment of patients (e.g., partners, parents, health care providers) can heighten an individual's risk for disability (Yeung et al., 2012; Cousins et al., 2015), for example through the protective or solicitous behaviour of social agents (Newton-John, 2002; Goubert and Simons, 2013). There is much less research on the social context as a possible source of resilience. Recently, the role of partners in promoting positive functioning in individuals with chronic pain has received research attention (e.g., Taylor et al., 2013; Kindt et al., 2015; 2016). Other studies have looked at psychological flexibility in parents (McCracken and Gauntlett-Gilbert, 2011; Wallace et al., 2015) and teacher support (Vervoort et al., 2014) as a buffer against negative outcomes in children with pain. The recently proposed dual-factor model of risk and resilience in the context of pediatric pain, the Ecological Resilience-Risk Model may promote future research endeavors in this area (Cousins et al., 2015).

Author contribution

Both authors have made substantial contributions to drafting and critically revising this manuscript.

Figure legend

Figure 1. A resilience approach to chronic pain.

A resilience approach in the context of chronic pain should take into account both *recovery* (from disability, depression, etc.; left spiral) and *sustainability* of optimal well-being and goal-directed engagement in values-based activities in the presence of pain (right spiral). As risk respectively resilience mechanisms can influence or moderate the other spiral, we must search for and target resilience mechanisms (right spiral) that contribute to both the right, upward spiral of sustainability of a good life, ánd simultaneously provide a buffer against the left, downward spiral of disability.

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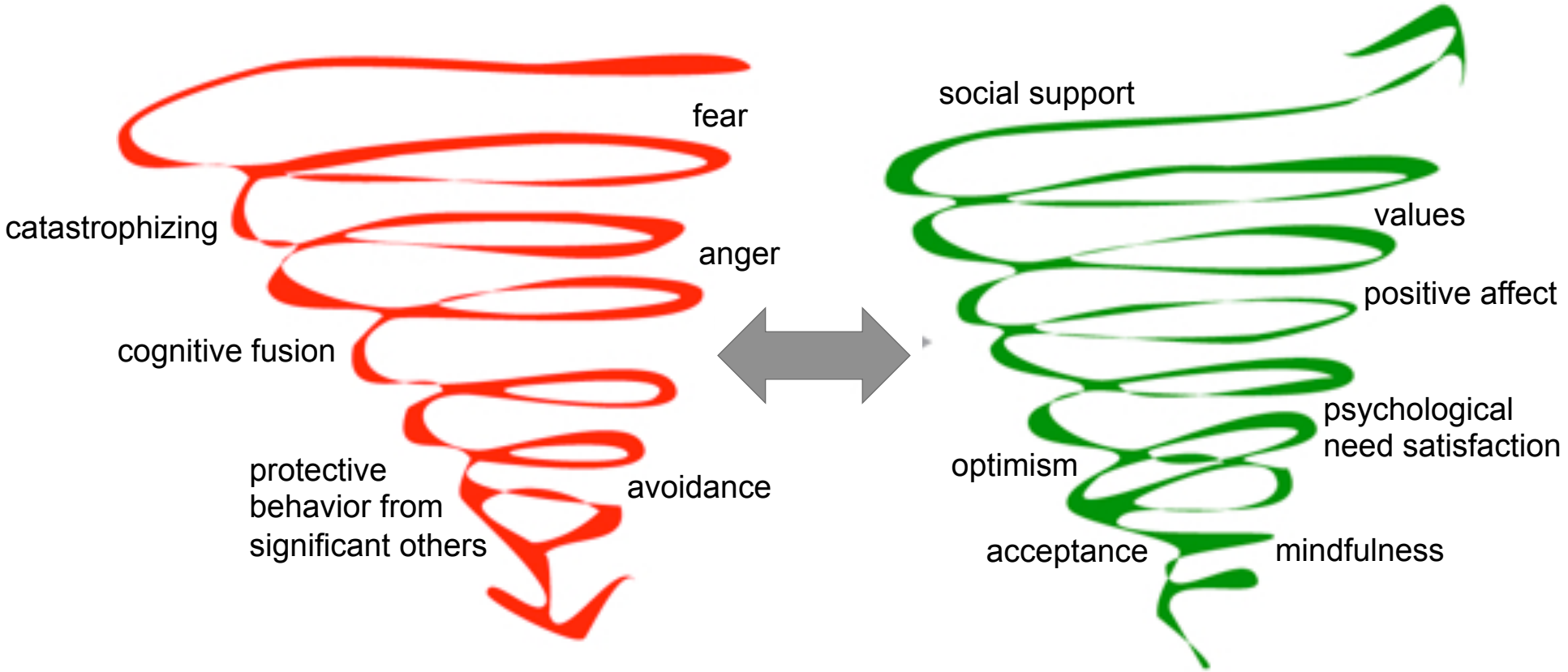
Pain

Pain

SUSTAINABILITY

ENGAGEMENT IN VALUES-BASED ACTIVITIES
OPTIMAL EMOTIONAL, PSYCHOLOGICAL
& SOCIAL WELL-BEING



DISABILITY
DEPRESSION
WORK LOSS

RECOVERY

Pain

Pain